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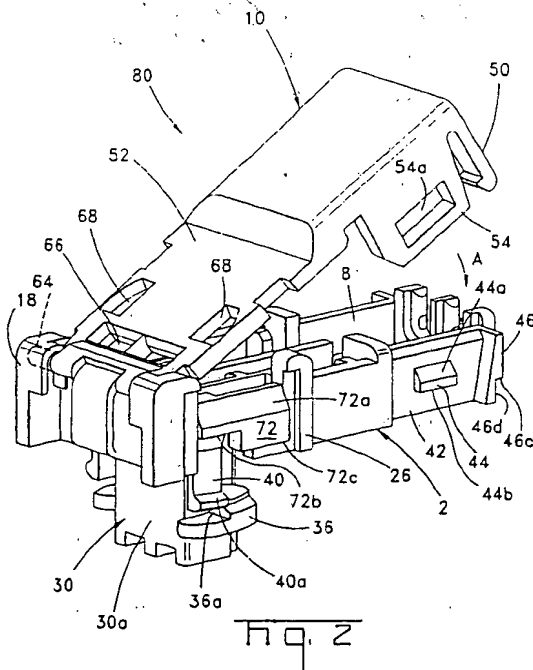
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(54) Electrical connector with a locking device

(57) The connector includes a housing (2) and a cover (10) integrally formed. Cover pins (64) engage housing support walls (18) and the cover is rotatable about the pins (64) so that cover latching arms (54) engage housing latching lugs (44). Cantilever lances (40) are positioned on either side of a coupling unit (30) which projects downwardly from the housing (2) for engagement with a mating connector with an internal latching groove with which the lances (40) engage when the

two connectors are partially engaged. Ends of convergent resilient beams of a locking device extend through cover slots (66) and engage a stop rib. The beam ends are disengaged from the stop rib by a projection of the mating connector upon full engagement of the two connectors thus permitting the locking device to be fully inserted into the housing (2) so that locking arms of the locking device are displaced outwardly into the latching groove and external latching members of the locking device engage latching lugs on the housing (2).



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Description

[0001] The present invention relates to electrical connectors, especially to the electrical connectors equipped with a locking device that locks upon the coupling with a mating connector.

[0002] Electrical connectors are known that are equipped with locking devices that can be inserted in the housing to secure the connection of the connector with its mating counterpart. Such locking devices reinforce connection formed with the mating connector, and examples of electrical connectors of this type can be found in Japanese Patent Disclosure Nos. 2647335 and 2647336. Locking devices used in these connectors are designed so that they are attached to the housing in advance and are inserted therein after the connector is coupled with its counterpart, thus reinforcing the completed electrical connection. However, since the design of these locking devices does not provide for a fixed retention location, there is always a risk that the locking device may be accidentally inserted in the housing. In such a case, attempts to couple the connectors may result in deformation or even damage of the locking device and other parts of the connector.

[0003] To improve this design, an electrical connector 100 shown in Figure 17 is disclosed in Japanese Patent Disclosure No. 9-326275. Electrical connector 100 has a housing 102 and a locking device 104 retained on the housing. The locking device 104, in turn, has a separate coupling-confirmation unit 106 that secures the locking device 104 in a specified location of the housing 102. Coupling-confirmation unit 106 has two arc-shaped lugs 110 joined together by a connecting bar 108. In a normal condition, the connecting bar 108 is engaged with the notches 114a in legs 114 of the locking device 104, thus preventing the locking device 104 from being inserted in the housing 102. Lower sections of the arc-shaped lugs 110 engage arc-shaped cams 112 of the housing 102. When housing 102 is coupled with a mating connector, the coupling-confirmation unit 106 is rotated by cams 112, thus changing the position of the connecting bar 108 and disengaging legs 114 therefrom, which results in the insertion of the locking device 104 in the housing 102.

[0004] However, the problem with the conventional electrical connector described in Japanese Patent Disclosure No. 9-326275 is that the locking device 104 must have a separate coupling-confirmation unit 106, thus making the design more complicated and increasing the number of parts and assembly operations.

[0005] Therefore, the purpose of the present invention is to provide an electrical connector that is free of the above-mentioned problems, that is, a connector of a simple design that does not contain separate parts and that can be easily assembled.

[0006] The locking device of the electrical connector according to the present invention has a pair of beams as integral parts of a locking device that are slanted to-

ward each other. The two beams have shoulders engaging with a stop member of the housing. Due to the engagement between the shoulders and the stop member, the locking device cannot be inserted in the housing before the housing is coupled with a mating connector. The important feature of the present invention is that during the coupling, the interaction of the mating connector with the beams results in releasing the engagement between the shoulders and the stop member so that the locking device can be moved to a locking position.

[0007] It is desirable that the stop member is wedge-shaped.

[0008] The shoulders are in the form of notches provided in edges facing each other of the beams.

[0009] The notches have a shape corresponding to that of the wedge-shaped stop member.

[0010] It is desirable that in the process of coupling, the beams are pushed apart to a position parallel to each other by a rib on the mating connector, and that the beams are maintained in the pushed-apart position by the rib inserted between them when the mating connector is inserted in the housing.

[0011] A locking device of an electrical connector according to the present invention has a pair of beams as an integral part of the locking device that are slanted in a direction toward each other. Engagement of shoulders of the beams with a stop member prevents the locking device from being inserted into the housing, but when the housing is coupled with a mating connector, the engagement between the shoulders and the stop member is released, thus rendering the following effect: namely, due to the fact that the two beams are an integral part of the locking device, the connector has fewer parts and a simpler construction. In addition, since the locking device is a single unit, the number of assembly operations is also reduced. Moreover, since the locking device can be disengaged from a stopped position only if a mating connector is coupled to the housing, an accidental insertion of the locking device into the housing is impossible, thus preventing the locking device from deformation or damage. Since the locking device cannot be inserted into the housing unless the connectors are fully coupled, it can be used as a detector of incomplete coupling of the connectors.

[0012] An embodiment of the present invention will now be described by way of example with reference to the accompanying drawings in which:

[0013] Figure 1 is an unfolded perspective view of a housing and a cover as an integral part of the housing and connected thereto by a hinge used in an electrical connector according to the present invention.

[0014] Figure 2 is a perspective view of the housing and cover shown in Figure 1 with the cover being near a closed position so as to close a housing opening.

[0015] Figure 3 is a perspective view of the connector with the cover being secured on the housing and a locking device being placed on the housing in a temporary retention position as seen from the front and the cou-

pling unit side.

[0016] Figure 4 is a top plan view of the electrical connector depicted in Figure 3.

[0017] Figure 5 is a side view of the electrical connector in a state before the coupling to a mating connector.

[0018] Figure 6 is a cross-sectional view taken along line 6-6 in Fig. 4 of the electrical connector coupled with the mating connector in the state shown in Fig. 5.

[0019] Figure 7 is a cross-sectional view taken along line 7-7 in Fig. 4 of the electrical connector coupled with the mating connector in the state shown in Fig. 5.

[0020] Figure 8 is a cross-sectional view taken along line 8-8 in Fig. 4 of the electrical connector coupled with the mating connector in the state shown in Fig. 5.

[0021] Figure 9 is a side view of the electrical connector coupled to the mating connector.

[0022] Figure 10 is a cross-sectional view similar to that shown in Figure 6 of the electrical connector in the state coupled with the mating connector as depicted in Figure 9.

[0023] Figure 11 is a cross-sectional view similar to that shown in Figure 7 of the electrical connector in the state coupled with the mating connector as depicted in Figure 9.

[0024] Figure 12 is a cross-sectional view similar to that shown in Figure 8 of the electrical connector in the state coupled with the mating connector as depicted in Figure 9.

[0025] Figure 13 is a side view similar to that depicted in Figure 5 showing the insertion of the locking device to a fully-engaged position with connectors in the coupled state.

[0026] Figure 14 is a cross-sectional view similar to that shown in Figure 6 of the electrical connector in the state coupled with the mating connector as depicted in Figure 13.

[0027] Figure 15 is a cross-sectional view similar to that shown in Figure 7 of the electrical connector in the state coupled with the mating connector as depicted in Figure 13.

[0028] Figure 16 is a cross-sectional view similar to that shown in Figure 8 of the electrical connector in the state coupled with the mating connector as depicted in Figure 13.

[0029] Figure 17 is an exploded perspective view of a conventional electrical connector.

[0030] Housing 2 as shown in Figures 1-3 is molded of a suitable plastic material and it has basically a rectangular shape. At its rear wall 12, two parallel U-shaped cut-outs 14 are provided for electrical wires W (see Fig. 4) that are explained below. Inside the housing 2, contact-receiving cavities 16 are located that are divided by a partition 16a separating two electrical terminals 150 (see Fig. 6) with attached wires W arranged inside the cavities. On both sides of a front section of the housing 2, two vertical supporting walls 18 are located as integral parts of the housing 2. At the top of supporting walls 18 on their inner sides, U-shaped ribs 22 facing down are

located. On both side walls 24, lugs 26 extending vertically are located as integral parts of the housing 2. At upper sections of lugs 26 and at upper sections of supporting walls 18, latching lugs 26a, 18a are located that extend in the same direction as side walls 24. Latching lugs 26a, 18a have downwardly-facing latching surfaces 26c, 18c. Side walls 24 between lugs 26 and supporting walls 18 have latching lugs 72 comprising upper tapered sections 72a and shoulders 72b, 72c located in a lower part and facing downward. Shoulder 72b is located above the shoulder 72c thereby forming a stepped shape.

[0031] At a bottom 28 of the front portion of the housing 2, a coupling unit 30 facing down is provided. The coupling unit 30 has a flat front surface 30a and curved surfaces 30b at both sides. A bottom surface 32 of the coupling unit 30 is a mating surface that has two depressions 34 therein. In a rear part of each depression 34, openings 34a are provided for the insertion of contacts 202 (see Fig. 6) of mating connector 200. At the curved surfaces 30b located near the bottom part of the coupling unit 30, a pair of bosses 36 are provided and they are arranged in a transverse direction relative to the housing 2, that is perpendicular to a longitudinal direction of the housing. Above the bosses 36, cantilever lances 40 are provided that extend downward from the housing 2. At the ends of the lances 40, in the vicinity of bosses 36, lance lugs 40a extending outward are located. Bosses 36 have stepped surfaces 36a that are lower at a front end in which the lance lugs 40a located at the ends of lances 40 are arranged.

[0032] Rear sections 42 of the side walls 24 of the housing 2 are displaced inside relative to the main sections of the side walls 24 and they have latching lugs 44 at their centers. Latching lugs 44 have tapered upper edges 44a extending in the longitudinal direction of the housing 2 and shoulders 44b located at a bottom of the latching lugs 44. At the end of the rear sections 42, vertical ribs 46 are provided that extend outward. At a bottom of an outer surface 46a of the ribs 46, shoulders 46c and surfaces 46d are located.

[0033] At the front section of the housing 2, cover 10 is located as an integral part of the housing and it is connected to the housing by integral hinge 6. Cover 10 is a rectangular member having a main body 52 and its dimensions are such that it fits over the upper opening 8 of the housing 2. At both sides of a rear end of the cover 10, cantilever latching arms 50 are located. In this case, the side of the cover 10 where it is connected to the housing 2 by the hinge 6 is a front end, and the side where the latching arms 50 are located is a rear end. At outer ends of the latching arms 50, lugs 50a are located that extend toward the front end. At both sides of the cover 10 near the latching arms 50, wide cover-latching arms 54 are located as integral members of the cover along both side edges 53 of the main body 52 that extend in the same direction as the cover. In the latching arms 54, rectangular openings 54a are provided whose

dimensions match those of the latching lugs 44. The front edges of the retaining arms 54 have inner tapered surfaces 54b (Figure 1) to serve as cam surfaces when the cover 10 is secured on the housing 2.

[0034] On an inner surface 56 of the main body 52, that is, on an upper surface as depicted in Figure 1, a step 58 is located that extends across the main body 52. In side edges 53 of the main body 52, cut-outs 62 are provided to accommodate lugs 26 of housing 2, and at the front end, cylindrical supporting pins 64 are located that extend outward in a transverse direction relative to the longitudinal direction of the cover 10. As can be seen from Figure 2, when the hinge 6 is partly folded to place the cover 10 over the opening 8, supporting pins 64 become engaged with the U-shaped ribs 22. In a front section of the main body 52, aligned slots 66 are located that are arranged perpendicular to the axis of the housing 2, and closely behind the slots 66, openings 68 are located near both edges 53 of the cover. One side of openings 68 that is located closer to the edge is curved. At a rear end of the main body 52, posts 70 having a curved shape 70a at an upper end are provided that correspond to the cut-outs 14 in housing 2. When the cover 10 is closed on the housing 2, posts 70 fit into the cut-outs 14 and clampingly engage wires W preventing them from being pulled out.

[0035] As can be seen from Figure 2, the cover 10 is attached to the housing 2 and rotated in the direction shown by arrow A until it is secured on the housing 2 covering the opening 8 as shown in Figure 3. At this time, openings 54a of the latching arms 54 and lugs 50a of the latching arms 50 become engaged with respective latching lugs 44 and shoulders 46c of the housing 2 thereby securing the cover 10 on the housing 2, thus completing the assembly of the housing unit 80.

[0036] Next, explanations concerning the locking device 20 with reference to Figure 3 are provided. The purpose of the locking device 20 is to reliably secure the mating connector 200 inserted in the housing 2. Locking device 20 includes a rectangular flat main body 76 and two latching members 77 extending obliquely from the main body 76 in an outward direction away from each other, but their lower portions extend parallel to each other. On outer ends of the latching members 77, projections 77a (see Fig. 8) are located and they extend inwardly. Lugs 77b protrude slightly in a longitudinal direction of the housing at the outer ends of latching members 77. Their purpose is to provide temporary attachment of the locking device 20 to the housing 2 by engaging with latching lugs 18a, 26a and with latching surfaces 18c, 26c. In such a state, the locking device 20 is temporarily retained on the housing 2.

[0037] At a front end of the main body 76 of the locking device 20, a pair of beams 78 extend downwardly from the main body 76. The beams 78 extend obliquely downward toward each other. Behind the beams 78, a pair of locking arms 82 extend down from the main body 76 parallel to each other and they are located at a greater

distance from each other than the beams 78. Functions of beams 78 and the locking arms 82 are explained in detail below.

[0038] As shown in Figure 4, the locking device 20 has an arcuate surface 76a located in a rear surface of the main body 76. The purpose of arcuate surface 76a is to provide a rest for the finger pressing on the cover 10 during the coupling of connector 1 and connector 200. Figure 4 shows electrical wires W extending from a back end of the housing 2.

[0039] Below, all steps of the process of the coupling of connector 1 to the mating connector 200 referring to Figures 5 through 16 is explained.

[0040] Figure 5 is a side view of connectors 1 and 200 immediately before the coupling. At this time, the locking device 20 is in the state of temporary retention on the housing 2. Figure 6 is a cross-sectional view through line 6-6 in Figure 4 when connectors 1 and 200 are in the positions depicted in Figure 5. Figure 7 represents a cross-sectional view through line 7-7 in Figure 4 when connectors 1 and 200 are in the position depicted in Figure 5. Figure 8 is a cross-sectional view through line 8-8 in Figure 4 of connectors 1 and 200 when they are in the position shown in Figure 5.

[0041] Figure 9 is a side view similar to that shown in Figure 5 when connectors 1 and 200 are coupled. At this time, the locking device 20 is still in the state of temporary retention. Figure 10 is a cross-sectional view similar to that depicted in Figure 6, but with the connectors coupled as in Figure 9. Figure 11 is a cross-sectional view similar to that shown in Figure 7, but with the connectors coupled as in Figure 9. Figure 12 is a cross-sectional view similar to that shown in Figure 8, but with the connectors coupled as in Figure 9. Figure 13 is a side view similar to that depicted in Figure 5 showing the state when the locking device 20 has been pushed into the fully-locked position with the connectors coupled to each other. Figure 14 is a cross-sectional view similar to that depicted in Figure 6 but showing the connectors coupled as shown in Figure 13. Figures 15 and 16 are cross-sectional views similar to those depicted in Figures 7 and 8, respectively, but when connectors are coupled as shown in Figure 13.

[0042] Referring first to Figure 5, it can be seen that connector 1 and connector 200 are in such a position that their mating surfaces are in the same plane but the connectors are not coupled yet. One can see that the lance 40 is placed in front of the coupling unit 30. It is clearly seen that in this state the lugs 77b are engaged with the latching surfaces 18c and 26c of the latching lugs 18a and 26a, respectively, thus attaching the locking device 20 to the housing 2.

[0043] Referring to the cross section shown in Figure 6, it can be seen that the connector 1 has L-shaped electrical contacts 150 arranged in the coupling unit 30. Each contact 150 has a contact section 152 forming electrical connection with a respective electrical contact 202 of the mating connector and a connecting section

154 located at an opposite end of the contact. The connecting section 154 is joined to the electrical conductor of the electrical wire W. As shown in Figure 6, the electrical wire is passed through a ferrite sleeve 156 installed for the elimination of electromagnetic interference. The beams 78 of the locking device 20 are passed through openings 66 of the cover 10 (Fig. 2) and extend through a bottom surface of the housing 2. The locking arms 82 are displaced with respect to the lances 40 in the longitudinal direction of the housing 2.

[0044] The mating connector 200 has a cylindrical housing 206 with a cavity 208 that accommodates a plastic retainer 210. Retainer 210 contains a metal member 204 short-circuiting two electrical contacts 202. Contacts 202 are arranged in a plane perpendicular to the surface of the paper, therefore, in Figure 6 only one contact 202 is visible.

[0045] The metal member 204 has a retaining section 214 that is inserted and secured in slot 212 of the retainer 210 and two spring-loaded arms 218 having a connecting section 218a extending from the retaining section 214 and front end sections 216 extending from the spring-loaded arms 218 toward contacts 202. Since the retaining section 214 connects all these sections together and the front end sections 216 form electric connection with the contacts 202, contacts 202 are normally short-circuited. On an inside surface of the housing 206, an annular latching groove 220 is formed at a location relatively close to the mating plane.

[0046] Next, referring to Figure 7, it can be seen that when the locking device 20 is in the state of temporary retention, the locking arms 82 pass through the openings 68 of the cover 10 and extend inside the housing 2. At the ends of the locking arms 82, locking lugs 82a are located that extend outward, but when the locking device 20 is in the state of temporary retention, the locking arms 82 are not engaged with any part of the housing. From Figure 7, it can be seen that the locking arms 82 and bosses 36 are aligned. It is also clear that the contacts 150 are arranged in 2 rows. The latching groove 220 of the housing 206 as shown in Figure 7 is exposed to the cavity 208 of the housing 206 to a greater degree than to the release portion 210a of the retainer 210.

[0047] Next, from Figure 8, it can be seen that when the locking device 20 is in the state of temporary retention, beams 78 are engaged with rib 90 of the housing 2 that has a wedge-shaped cross section. In such a position, downward-directed shoulders of notches 78a in opposed surfaces 75 near the ends of the beams 78 engage against upper surface 90a of the rib 90, thus blocking downward movement of beams 78. From Figure 8, it can be seen that beams 78 and lances 40 are at approximately the same position. In the housing 206 of the mating connector 200, two contacts 202 and front end 216 of the metal member 204 that forms electrical connection with contacts 202 can be seen.

[0048] Figure 9 shows the state in which connectors

1 and 200 are coupled together, but the locking device 20 is still in the state of temporary retention. At this time, as can be seen from Figure 10, electrical connection between the contacts 150 and 202 is accomplished. That is, male or pin contacts 202 are inserted in female or receptacle contacts 150 and the electrical connection therebetween is completed. At this time, the front end 216 of the metal member 204 is still electrically connected to contacts 202.

[0049] As can be seen from Figure 11, bosses 36 of the coupling unit 30 are near the bottom of the retainer 210, and the upper-sloped surfaces 36a of the bosses 36 are positioned next to the annular latching groove 220. Male contacts 202 are omitted in Figure 11. Mutual position of the locking device 20 and the housing 2 is the same as in Figure 7.

[0050] Next, referring to Figure 12, attention must be given to the fact that lance lugs 40a of lances 40 of the housing 2 are engaged with the latching groove 220. Since in such a state the lances 40 will be bent inwardly if the housing 2 is pulled upward, the housing 2 can be detached, and such a state corresponds to temporary retention of the housing 2 and the connector 200. Tapered surfaces 79 at the outer ends of beams 78 of the locking device 20 engage with upper edges of projection 230 of the housing 206 which spreads the beams 78 to the width equal to that of the projection 230 so that beams 78 are now parallel to each other. This results in releasing the engagement of the beams 78 of the locking device 20 from the wedge-shaped rib 90, thus enabling downward movement of the locking device 20.

[0051] When the locking device 20 is fully inserted, an upper surface of the locking device 20, as can be seen from Figure 13, is substantially on the same level as an upper rear surface of the cover 10. In such a state, the position of the locking device 20 inside the housing 206 can be explained as follows. When the locking device 20 is pushed downward, the beams 78 slide between bosses 30 and the spring-loaded arms 218 of the metal member 204 forcing the spring-loaded arms 218 to the side as shown in Figure 14. As a result, front end sections 216 of the metal member 204 are separated from the contacts 202, thus breaking the short-circuiting of contacts 202.

[0052] In this state, as can be seen from Figure 15, as the locking device 20 is pushed farther down, the outer ends of the locking arms 82 of the locking device 20 reach the slanted surfaces 36a of the bosses 36 and are spread apart so that locking lugs 82a of the locking arms 82 enter the latching groove 220. Since at the same time, the latching arms 77 become latched due to the fact that projections 77a become engaged with shoulders 72c of the latching lugs 72 (see Fig. 2), the locking device 20 and the housing 2 cannot be moved upward. This is the fully-locked state of the locking device 20. Therefore, the connector 1 becomes reliably coupled with the connector 200. In addition, the locking arms 82 follow the curved surface 30b of the coupling unit 30

(Fig. 3) thereby coming closer to the lances 40. Therefore, outside surfaces of locking arms 82 become curved, and the locking lugs 82a also follow the curved surfaces 30b, thus providing an additional retention by engaging with the annular latching groove 220.

[0053] If the housing 2 is not fully inserted in the connector 200, the bosses 36 block the annular latching groove 220, thus preventing the locking lugs 82a of the locking arms 82 to become engaged with the latching groove 220 and making it impossible to press the locking device 20 into the housing 2. This feature can be used as a detector of an incomplete coupling of the housing 2. In addition, since the latching arms 77 of the locking device 20 cannot be locked in the housing 2, the incompleteness of the coupling can be easily established by absence of the characteristic clicking sound that takes place when the projections 77a of the latching arms 77 engage latching lugs 72.

[0054] As can be seen from Figure 16, beams 78 are located near the bottom of the retainer 210, and since the projection 230 is located between the beams 78, the wedge-shaped rib 90 does not interfere with them and the beams 78 remain parallel to each other. The lances 40 remain in the latched state as explained with reference to Figure 12. Since the front end sections 216 of the metal member 204 are located in the depressions 34 (Fig. 3), they do not interfere with the housing 2.

[0055] Above, detailed explanations concerning a preferred embodiment of the present invention have been provided; however, the embodiment is only an example and the invention is not limited to this specific embodiment. For example, experts in the field may introduce various modifications in the design of the locking device and configuration of beams without departure from the features of the invention.

Claims

1. An electrical connector (1) for matable connection with a mating electrical connector (200) comprising a dielectric housing (2) having contact-receiving cavities (16) for receiving electrical contacts (150) therein an a stop member (90), a locking device (20) movably mounted on the dielectric housing (2), beams (78) provided by the locking device and engageable with the stop member (90) to cause the locking device (20) to remain in a temporary position, characterised in that

means (79) provided on the beams (78) engage with a projection (230) in the mating electrical connector (200) during mating engagement therewith causing the beams (78) to be released from the stop member (90) thereby enabling the locking device (20) to be moved from the temporary position to a fully-locked position, and latching arms (77) on the locking device (20) engage latching lugs (72) on the housing (2) when the locking device (20) is at

the fully-locked position.

2. An electrical connector according to claim 1 wherein the stop member (90) has a wedge shape.
3. An electrical connector according to claim 1 or 2, wherein the beams (78) extend toward one another and include notches (78a) in opposing surfaces having downwardly-directed shoulders for engaging an upper surface of the stop member (90).
4. An electrical connector according to any preceding claim wherein the engaging means on the beams comprise tapered surfaces (79) at outer ends of the beams (78).
5. An electrical connector according to any preceding claim wherein a coupling unit (30) extends downwardly from a front end of the dielectric housing (2) in which contact sections of the electrical contacts (150) are disposed and is positioned within the mating electrical connector (200) when the electrical connector (1) is mated therewith.
6. An electrical connector according to claim 5 wherein the coupling unit (30) includes bosses (36).
7. An electrical connector according to claim 6 wherein locking arms (82) having locking lugs (82a) are provided by the locking device (20), and the locking arms (82) engage the bosses (36) of the coupling unit (30) when the coupling unit is positioned within the mating electrical connector (200) causing the locking lugs (82a) to be disposed in a latching groove (220) in the mating electrical connector (200) thereby locking the electrical connector (1) and the mating electrical connector (200) together in a fully mated position.
8. An electrical connector according to claim 5, 6 or 7 wherein the coupling unit (30) includes lances (40) having lance lugs (40a) for engagement with a latching groove (220) in the mating electrical connector (200) thereby latching the electrical connector (1) and the mating electrical connector (200) together in a temporary retention position.

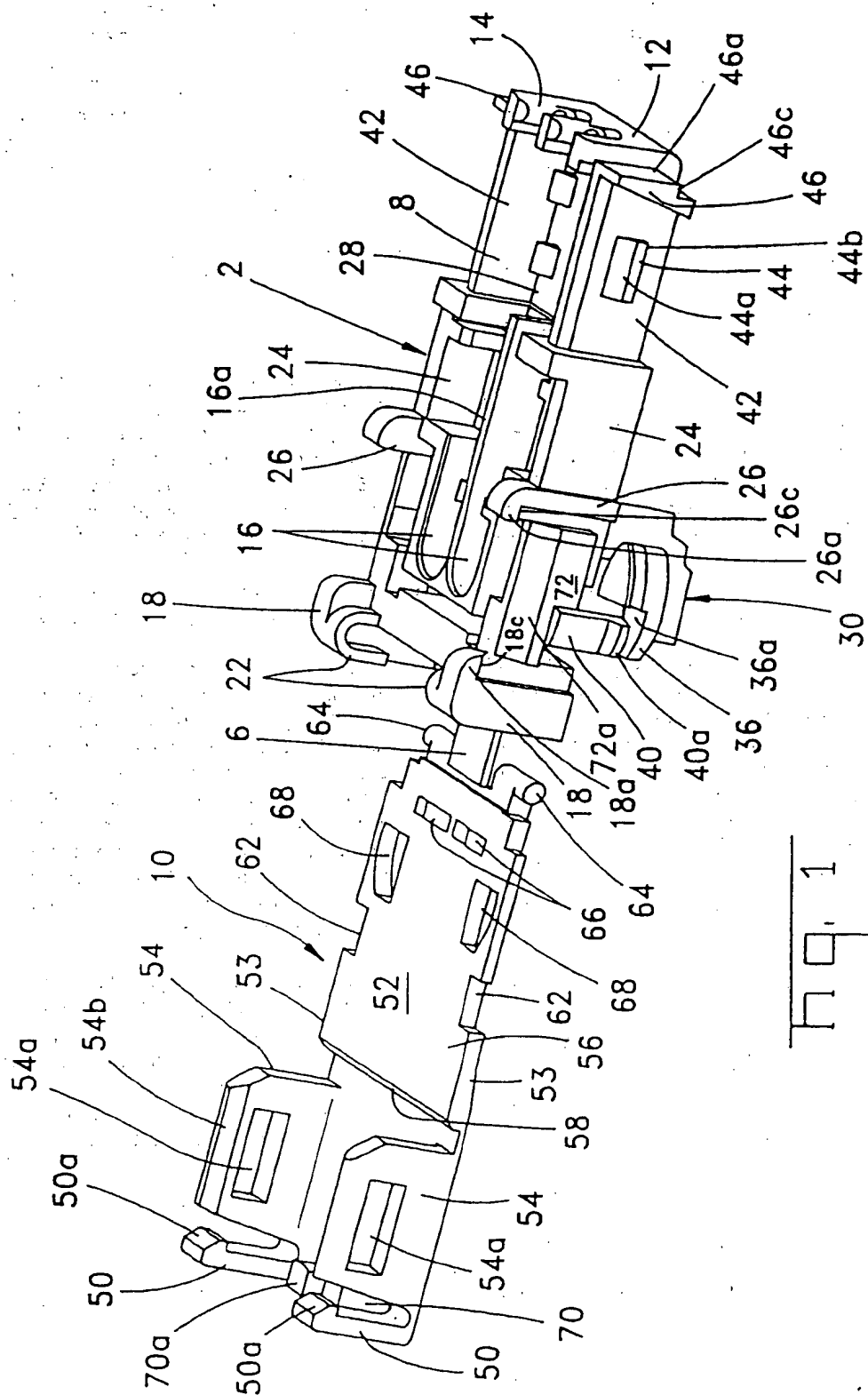
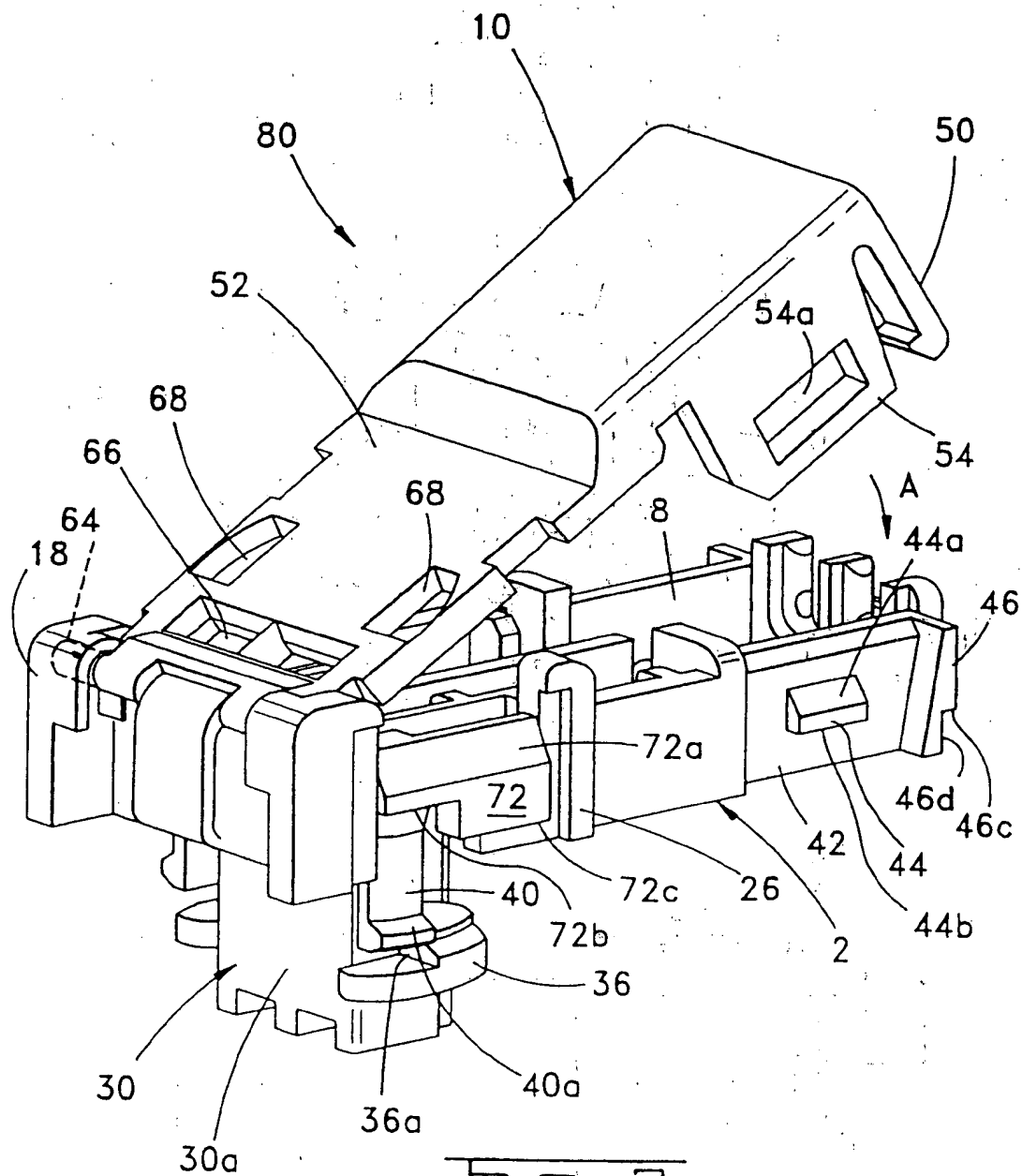
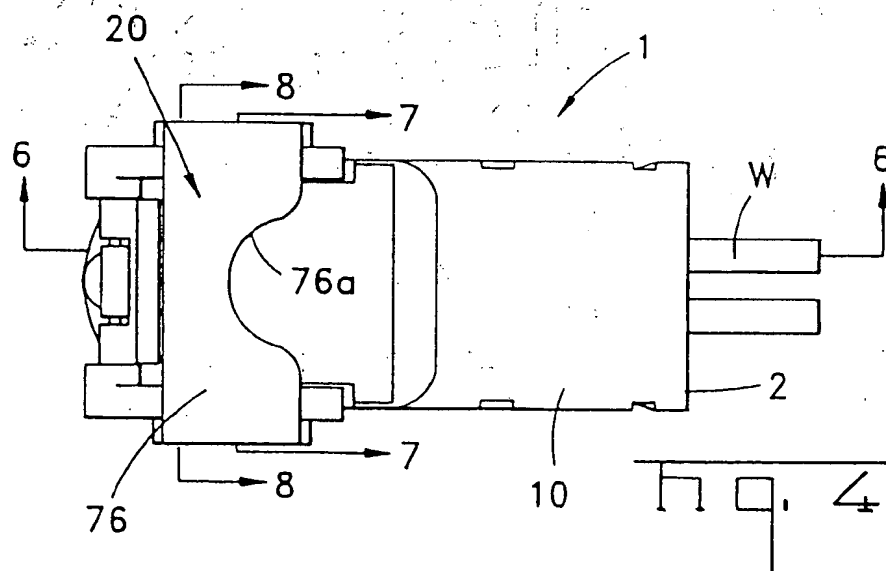
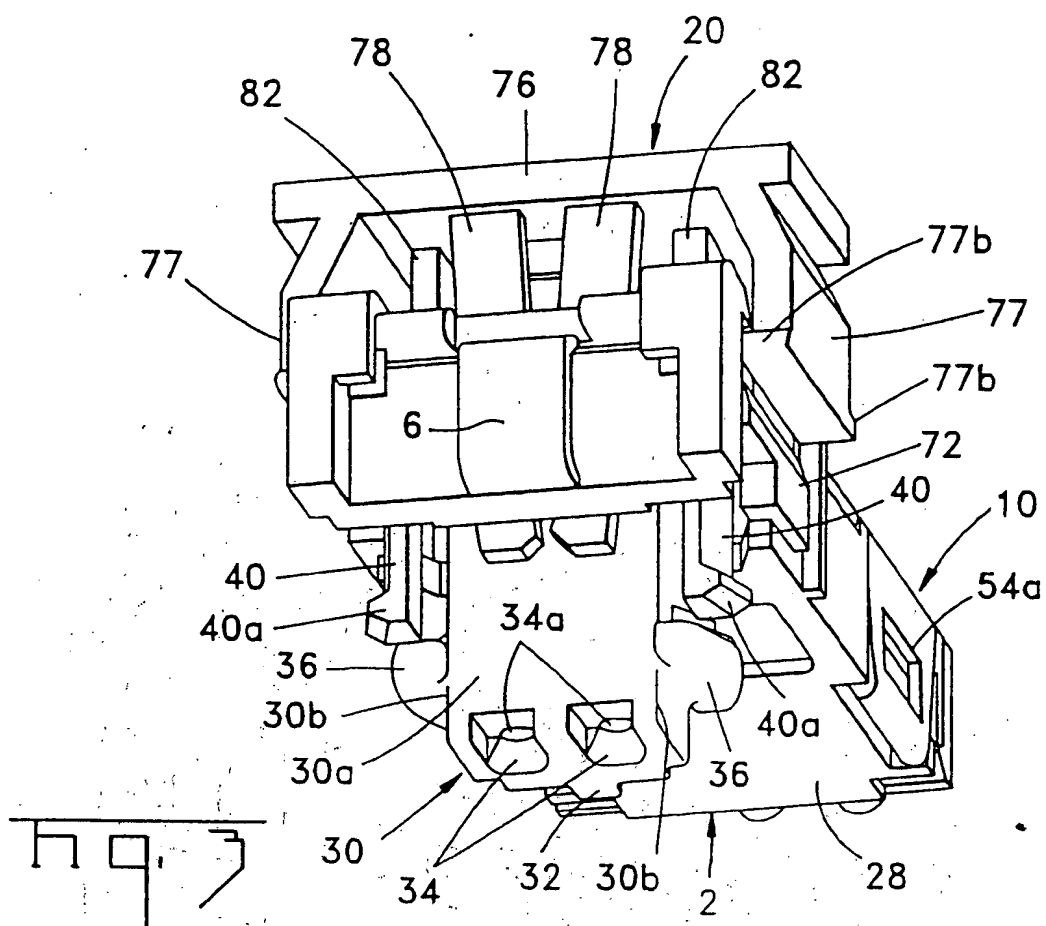
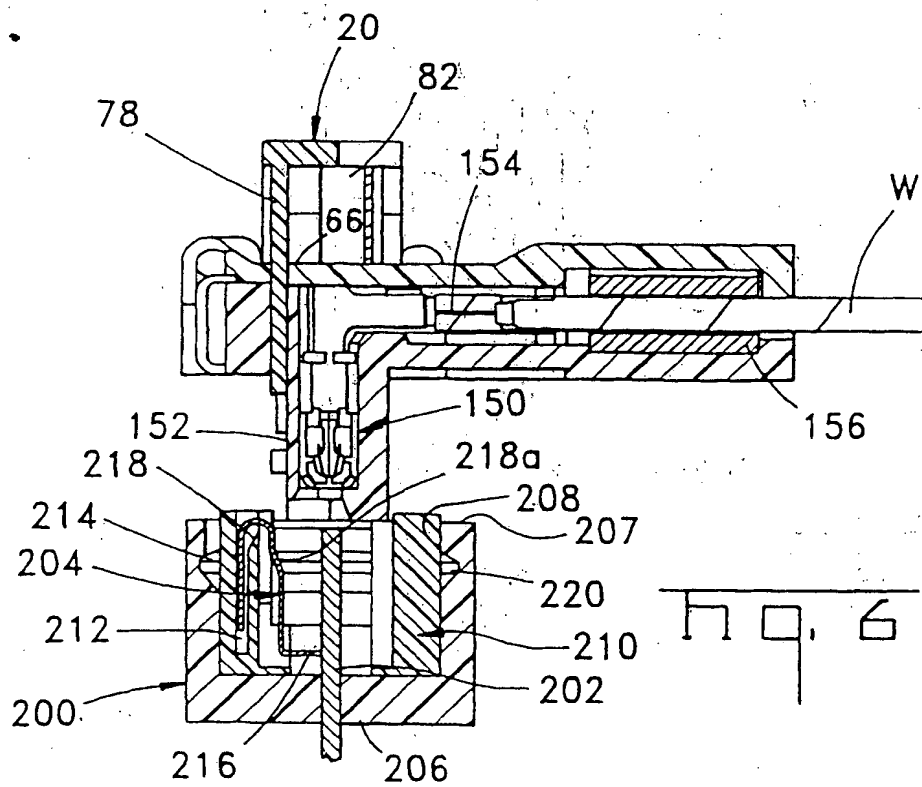
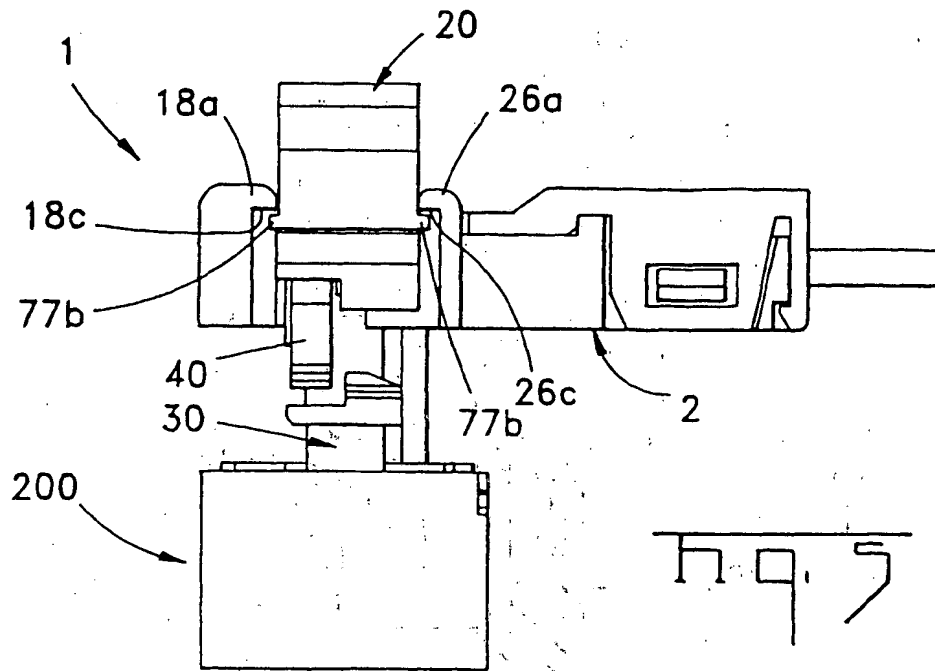


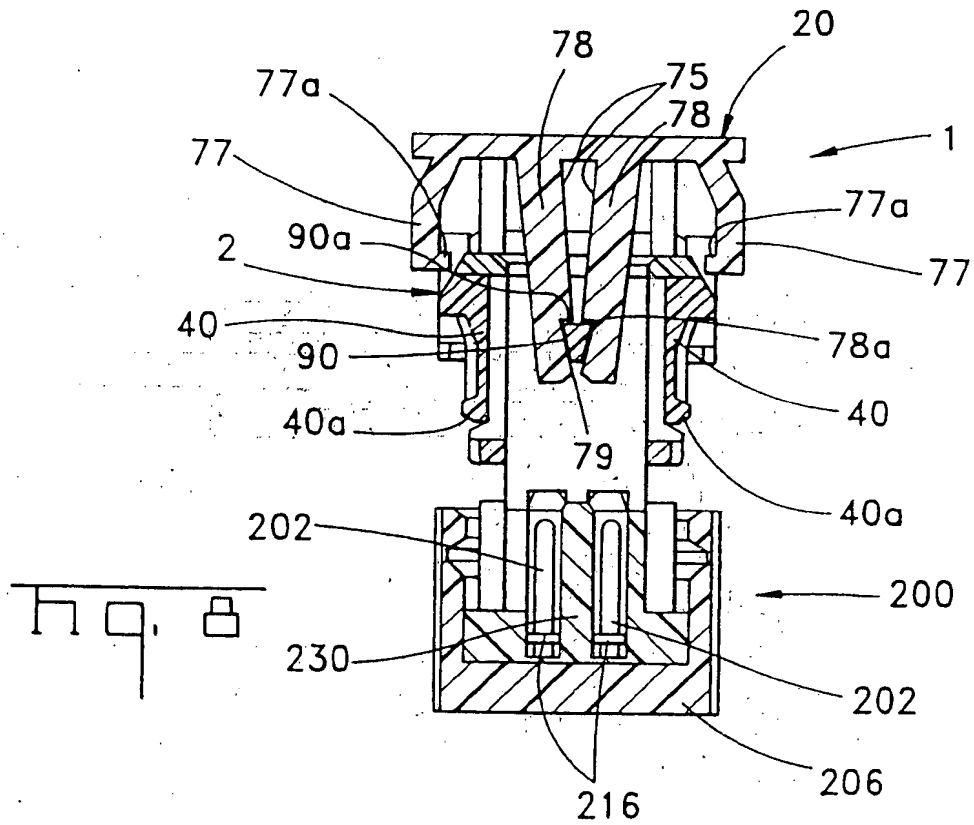
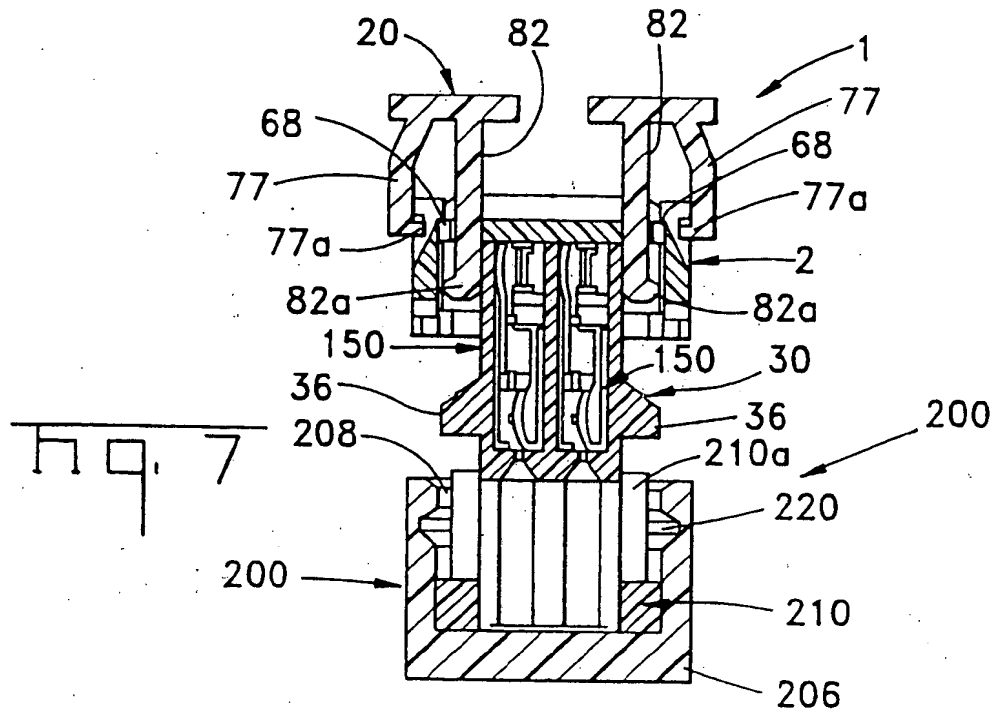
Fig. 1

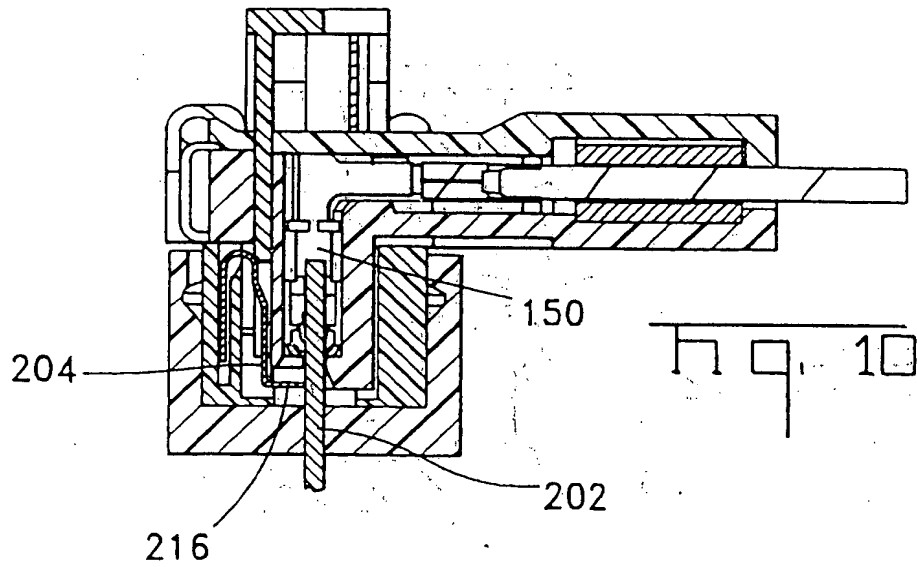
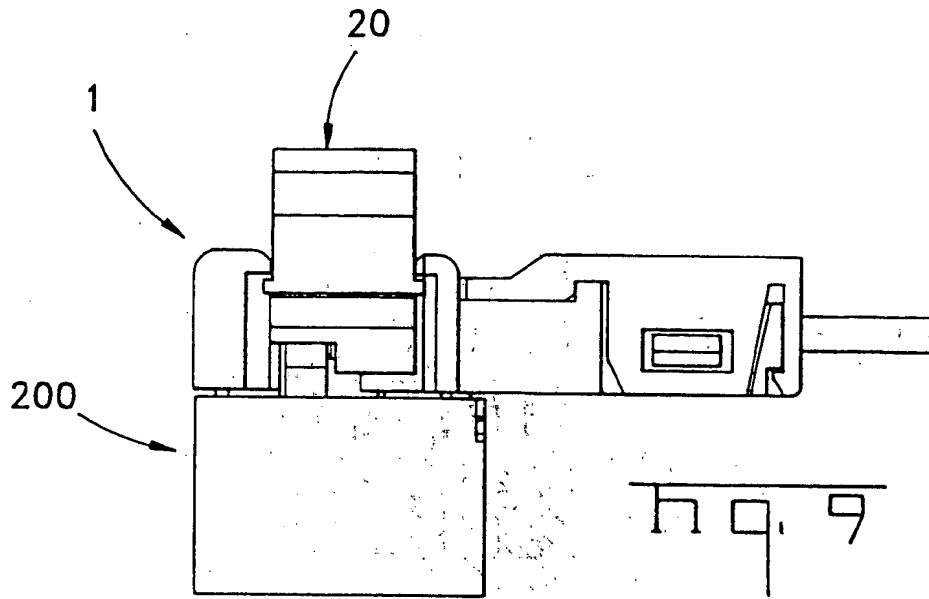


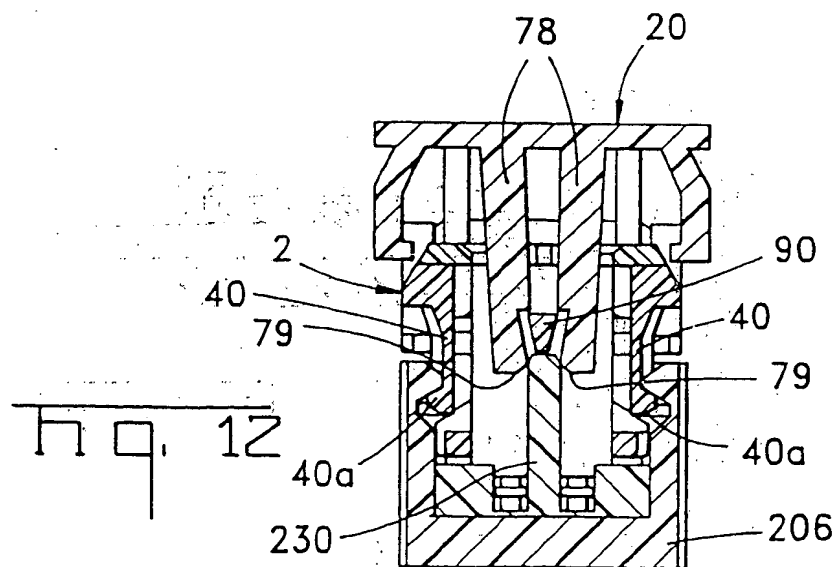
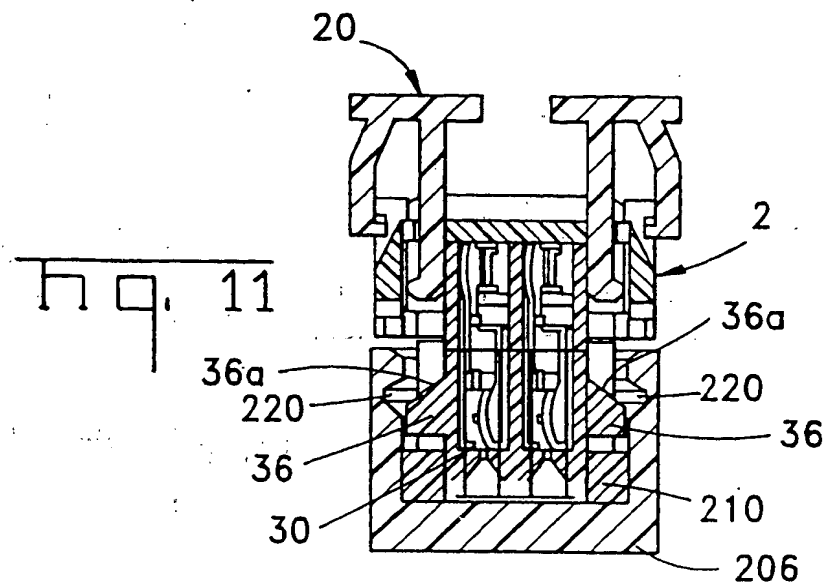
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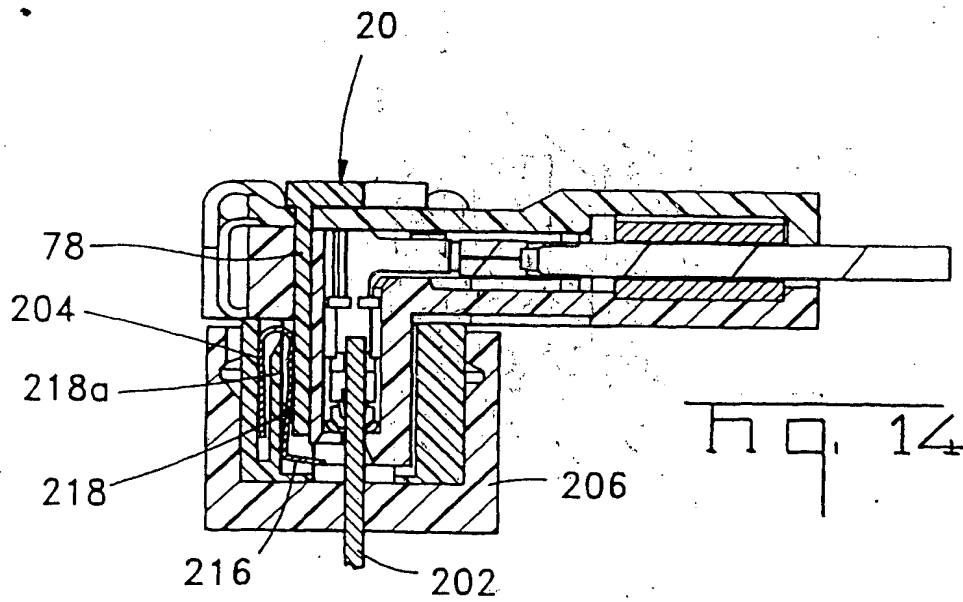
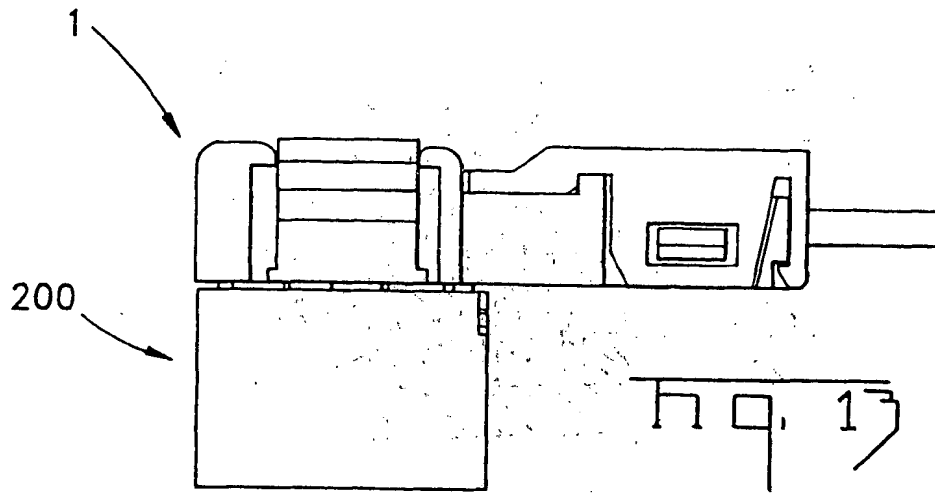












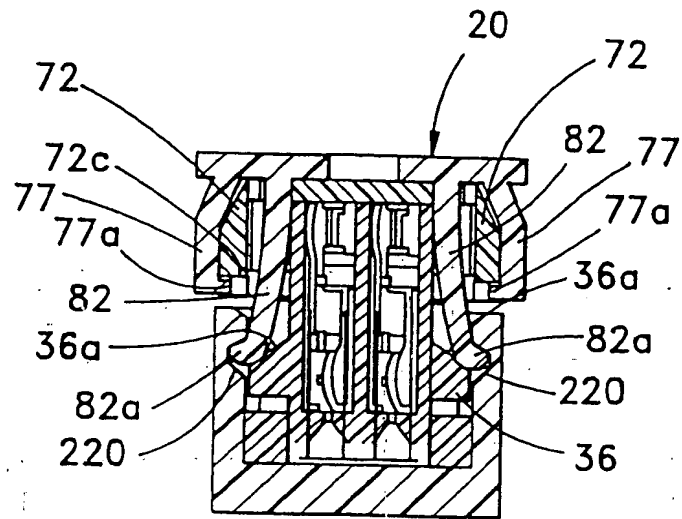


Fig. 15

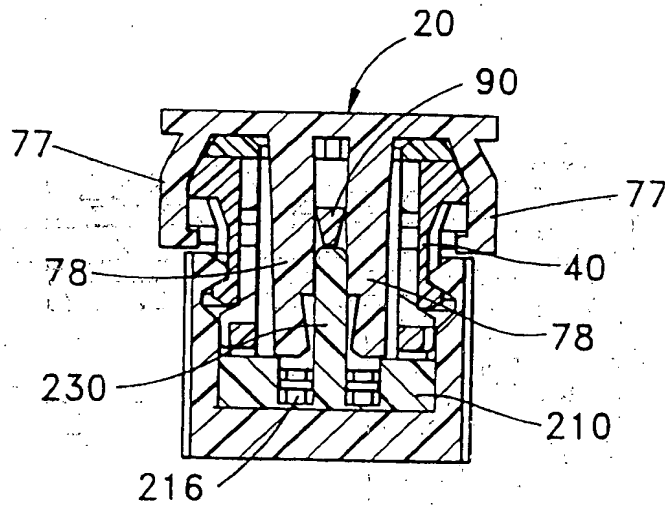
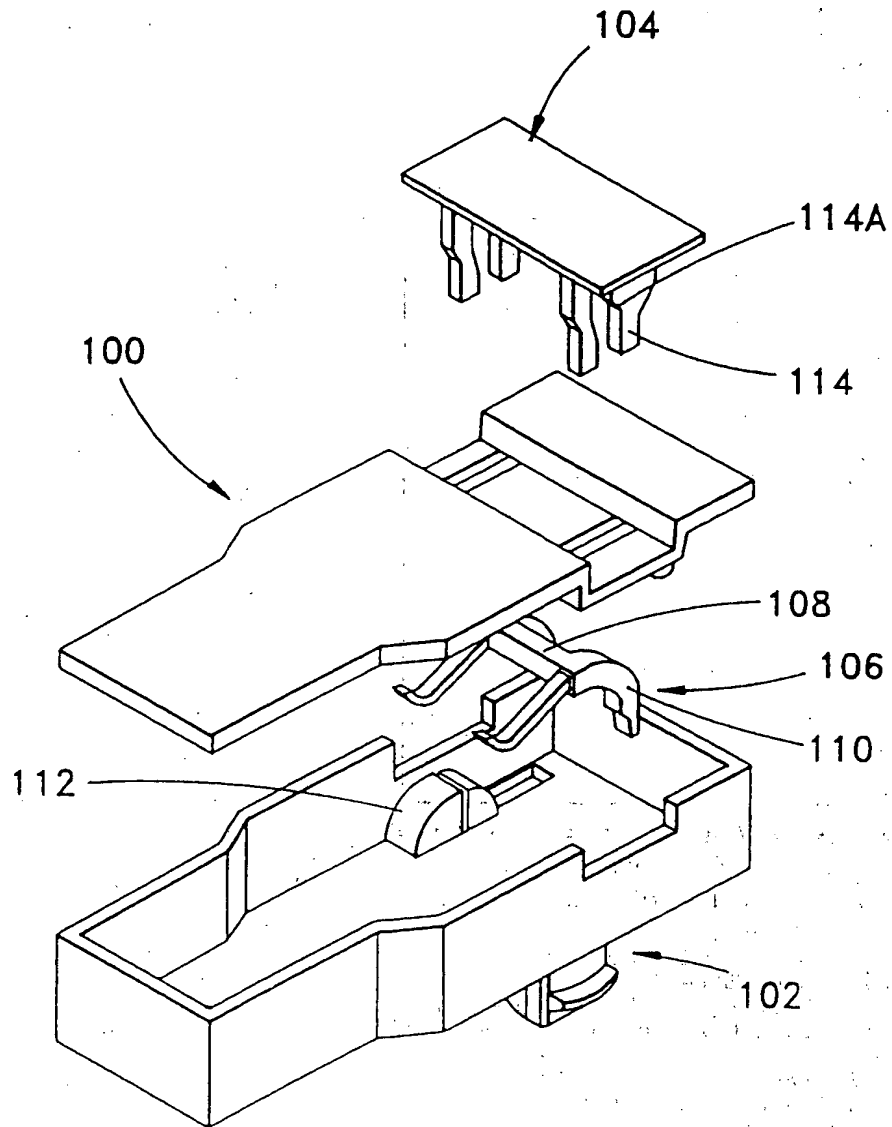


Fig. 16



(PRIOR ART)

Fig. 17